Section II (Remarks)

Amendment of Claims 1 and 14, and Addition of New Claims 35 and 36

Claim 14 has been amended herein to recite:

> **"wherein the apparatus is constructed and arranged so that the wafer being plated is a monitoring electrode in the monitoring conducted by the computational module, and wherein the computational module is adapted for coupling in signal transmission relationship with the wafer."**

Such recital is consistent with the disclosure in the application, e.g., in the Abstract at lines 3 – 7 thereof.

Claim 1 previously withdrawn, has been correspondingly amended to recite:

> **"wherein the wafer being plated is utilized as a monitoring electrode in the monitoring conducted by the computational module, with said monitoring electrode being coupled in signal transmission relationship to said computational module."**

In addition Claims 35 and 36 have been added, to encompass specific aspects of the invention.

Claim 35 recites:

> **35. An electrochemical deposition system comprising a wafer plating apparatus in which a wafer is contacted with electrochemical deposition medium, and a metrology apparatus for monitoring operation of the plating apparatus, wherein the plating apparatus is constructed and arranged with respect to the metrology apparatus so that the wafer is a monitoring electrode in monitoring operation of said metrology apparatus, and the wafer is coupled in signal transmission relationship to the metrology apparatus.**

Such claim is supported by the original disclosure, including the aforementioned textural portion of the abstract.

New Claim 36 has been added, directed to a specific embodiment of the invention described in paragraphs [0034] – [0040] of the application as published (U.S. Patent Application Publication 2005/0109624):

36. **An electrochemical deposition system comprising a plating apparatus in which a wafer is contacted with electrochemical deposition medium including suppressor, accelerator and leveler additives, and a computational module adapted for signal processing, monitoring and control of the electrochemical deposition in the plating apparatus, wherein the plating apparatus is constructed and arranged with respect to the computational module so that the wafer is a monitoring electrode for said monitoring by the computational module, the computational module is adapted for coupling in signal transmission relationship with the wafer so that the computational module receives signal information from the wafer during said monitoring, the computational module is adapted to hold plating current constant and monitor plating voltage with time, to model plating current, nucleation voltage, accelerator concentration, leveler concentration and suppressor concentration in a regression analysis modeling operation, to determine from said regression analysis modeling operation, concentrations of the accelerator, leveler and suppressor for electrochemical deposition operation, and the computational module is adapted to responsively modulate the system for said control of the electrochemical deposition in the plating apparatus.**

The fee payable for addition of new Claims 35 and 36 is being paid at the time of EFS submission of this Response and accompanying RCE.

Filing of RCE

As indicated above, a request for continuing examination (RCE) is being filed with this Response, to continue the examination of this application.

Applicants hereby affirm the remarks distinguishing the pending claims over the cited art, as contained in the Response to the November 9, 2007 Office Action. The April 10, 2008 Advisory Action did not indicate whether such March 10, 2008 Response had been entered, since box 8 on the Advisory Action form had been checked, reflecting that evidence filed after final action had not been entered. Nonetheless, the Advisory Action in the continuation of box 11 appeared to reflect the examiner's consideration of such March 10, 2008 Response.

The Prior Rejection

Andricacos U.S. Patent 5,352,350 does not teach a computational module arranged to carry on regression analysis. It is noted that the textural portion referred to in Andricacos as the basis for

prior rejection fails to describe any regression analysis or multi-variant computation modeling of the deposition with a wafer-based independent variable to generate a dependent variable equation for each dependent variable correlative of efficacy of the copper electrochemical deposition. Andricacos therefore fails to describe solving such equation to yield a solution value for each dependent variable, and modulating the electrochemical deposition in response to the solution value for each selected dependent variable.

The Advisory Action at page 3, lines 3-9 states that:

> **"even though the prior art does not use the term "regression analysis" explicitly, Applicant is reminded that regression analysis includes predicting a dependent variable based on a independent variable, and, Andricacos et al. gives an explanation in col. 7, line 65 to col. 8, line 2, wherein an equation coefficient (k) is determined empirically (Δs is change in process service, i.e., plating current, the wafer-based independent variable)."**
>
> (November 9, 2007 Office Action)

In fact, this cited disclosure in Andricacos:

> **"Assign for each D species an apparent stoichiometric coefficient k_i according to the equation $\Delta c_i = k_i \Delta s$ (Using this equation, k_i can be calculated by empirically determining Δc_i and Δs) k_i will be negative for depleting species, positive for accumulating species, and zero for nonP species."**
>
> **(Andricacos, column 7, line 65 to column 8, line 2)**

fails to describe or provide any basis for:

> **"selecting at least one dependent variable correlative of efficacy of the copper electrochemical deposition;**
>
> **performing a regression analysis or multivariate calibration modeling of the copper electrochemical deposition utilizing a wafer-based independent variable to generate a dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition; and**
>
> **solving the dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition, by regression analysis, to yield a solution value for each selected dependent variable,"**

as required by applicants' claim 14.

In Adricacos' equation, $\Delta c_i = k_i \Delta s$, it is expressly taught that "k_i can be calculated by empirically determining Δc_i and Δs." Δc_i is the empirically-determined concentration change, and Δs is the empirically-determined "amount of Faradaic charge that has been passed (e.g., the time integral of the plating current)" as described at column 6, lines 50-51 of Andricacos.

Now, if the concentration change Δc_i is empirically determined, and if the cumulative plating current Δs (e.g., in amp-hours) is empirically determined, then the stoichiometric coefficient k_i for the feed component species i is directly calculated. Andricacos then goes on to teach at column 8, lines 26-28, in reference to the feed stocks, that "each is added to the bath in the quantity prescribed by the estimated reaction stoichiometry" based on such empirically based stoichiometric coefficient.

This is not regression analysis. It is instead empirical determination of concentration change and empirical measurement of amp-hours to calculate a stoichiometric coefficient, and then putting the calculated stoichiometric coefficient into the reaction equation to determine a quantity of the feed stock to add to the plating bath. As stated in the Abstract of Andricacos,

> "**All chemical species that are deliberately included in the bath are kept at constant concentration primarily by a method of compensating for their depletion or generation with a set of feed solutions that are formulated and dosed into the bath in accordance with an overall material balance…Maintaining all bath chemical species at constant concentration prevents bath aging and permits production of more uniform work pieces from the bath.**"

Andricacos therefore does not teach modeling of variables and parameters, in which the parameters are adjusted so as to give a best fit to the data, as required to carry out regression analysis. Andricacos thus does not anticipate applicants' claim 1 requiring a computational module arranged to carry out regression analysis involving:

> **"selecting at least one dependent variable correlative of efficacy of the copper electrochemical deposition;**
>
> **performing a regression analysis or multivariate calibration modeling of the copper electrochemical deposition utilizing a**

> **wafer-based independent variable to generate a dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition; and**
>
> **solving the dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition, by regression analysis, to yield a solution value for each selected dependent variable,"**

as required by applicants' claim 14.

Further, Andricacos fails to describe or provide any derivative basis for a system:

> **"wherein the apparatus is constructed and arranged so that the wafer being plated is a monitoring electrode in the monitoring conducted by the computational module, and wherein the computational module is adapted for coupling in signal transmission relationship with the wafer,"**

as required by applicants' claim 14. There is no such monitoring arrangement in Andricacos.

Claim 14 is therefore patentably distinguished over Andricacos, as are claims dependent from claim 14.

Concerning the further citation of Chung, such reference has been cited for teaching of plating of a seed layer on a workpiece in a plating bath arrangement, but there is no teaching of regression analysis in Chung.

Chung merely presents a multi-step potentiostatic/galvanostatic plating process in which a sub-threshold voltage is applied to a cathode and anode during a first time period, and a current is applied to the cathode and anode during a second time period so that the current produces a voltage below the threshold voltage, or, alternatively, a current ramp-up process with the same sub-threshold voltage objective.

Concerning newly added claims 35 and 36, there is likewise no derivative basis in the cited references for the systems recited in such claims.

Claim 1 has been correspondingly amended to Claim 14, to facilitate rejoinder under the provisions of MPEP 821.04 upon identification of allowable subject matter in the claims currently under examination.

For the all the foregoing reasons, it is requested that the prior rejection of claims be reconsidered in light of the amendments made herein and the preceding remarks, and that Claims 14 – 36 be acknowledged as allowable, with subsequent rejoinder of Claims 1 – 13 thereto pursuant to the requirements of MPEP 821.04.

CONCLUSION

Based on the foregoing, all of Applicants' pending claims 1-36 are patentably distinguished over the art, and in form and condition for allowance. The examiner is requested to favorably consider the foregoing, and to responsively issue a Notice of Allowance. If any issues require further resolution, the examiner is requested to contact the undersigned attorney at (919) 419-9350 to discuss same.

Respectfully submitted,

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